Only the introduction to the Pelecypods is contained in Part 1, but its improvement over the original is manifest, and we are able to form some idea of what may be expected from Dr. Dall, on this group and the Gastropods. The appearance of the concluding part of the first volume will be awaited with great interest, since without doubt the contributions of Messrs. Hyatt, Beecher, Clarke, Scudder, and others who are understood to be engaged on its revision will so elevate the character of the work as to render it the standard authority on the subject for years to come.

Palæontological science is certainly beholden to Wachsmuth, Sladen, Ulrich, Schuchert, Dall, and the others for their labors of love in trying to make this an authoritative and trustworthy text-book. How well they have succeeded remains to be determined after the book has been used in the laboratory, and it is certainly to have a wide use here. The improvement is so marked over the German edition, the "translation" contains so little from the original, and the "revision" is so complete that the question naturally arises whether Dr. Eastman could not just as well have gone a little farther in his work and made it a text-book by American authors which would have held the same place among English-speaking people as the original *Handbuch* does among the Europeans.

CHARLES R. KEYES.

Die Eruptivgesteine des Kristianiagebietes. II. Die Eruptionsfolge der triadischen Eruptivgesteine bei Predazzo in Südtyrol. By PROFESSOR W. C. BRÖGGER. Pp. 1–183, with 19 figures in the text. Kristiania, 1895.

For the purpose of gaining more light upon certain eruptive relationships of the rocks of the Christiania region, Professor Brögger and his friend Professor Ussing spent eight days in studying this classic locality of the south Tyrol. In a delightful introduction some idea is given of the perennial interest of the region to geologists by reference to the long roll of the most famous workers in geology preserved in the old guest-book of the "Golden Ship" at Predazzo.

The name *monzonite* (from the village of Monzoni) was first applied to the eruptive rocks of this region by Lapparent in 1864, but since his time different authors have used it in various senses. The earlier writers usually referred to these rocks as syenites. Tschermak in 1869

defined monzonite as a peculiar rock varying between syenite and diorite as extremes. His name was for a *geological* unit, however, and was not a petrographic definition. Dölter in 1875 adopted a similar usage; hand specimens of monzonite were syenite, diorite, gabbro, augitfels, or diabase. Rosenbusch, Teall, and Zirkel refer to monzonite as augite syenite. Nearly all writers have agreed in regarding the rocks of this locality as a series of intimately related members, ranging from acid to basic chemical composition, but have differed as to which is the main type.

In the laboratory the author's collection of specimens was found to fall into two groups — an acid group with 50–60 per cent. of silica, and a basic group with less than 50 per cent. of silica. The former group is the main one and embraces the monzonites proper, which are orthoclase-plagioclase rocks; while the latter are pyroxenites, and are merely peripheral facies of the monzonite, into which they grade. The term *monzonite* is thus given definite petrographic significance as the name of a transition or intermediate group of rocks between the orthoclase rocks (syenites) on the one hand, and the plagioclase rocks (diorites) on the other. The former method of uniting such a transition group with one or other of the limiting members of the series would, in this case, fail to express the most characteristic thing about these rocks, viz., that they contain plagioclase and orthoclase in about equal proportions.

Chemical investigation still further shows the need for a special name for the group. The probable range in silica percentage in all the monzonites is from 62–60 per cent. down to 50–48 per cent. This excludes all granites, quartz diorites, and quartz syenites from the comparison. The gabbros, too, are mostly more basic, have lower alkali contents, higher lime, and generally higher magnesia and iron oxides. A direct comparison, then, is necessary only with the syenites and diorites. The nepheline syenites have about the same silica contents as the monzonites, but are otherwise very different, as is shown by the following ratios deduced from thirteen analyses of nepheline syenites, and five of monzonites:

Nepheline syenite - -	$Ca : Na_2O : K_2O :: 1 : 4 : 2$
Monzonite - - -	$CaO : Na_2O : K_2O :: 10 : 4 : 3$

The chemical affinities of monzonite with the syenites and diorites are shown in the following table. All the analyses used for compari-

son were carefully chosen so as to secure typical and unaltered plutonic rocks.

	Potash Syenite	Soda Syenite	Monzonite	Diorite
SiO_2	60.57	58.32	55.88	56.52
TiO_2	.53	.54	not det.	.25
Al_2O_3	15.85	18.23	18.77	16.31
Fe_2O_3 (FeO, MnO)	8.23	7.16	8.20	11.09
MgO	2.59	1.31	2.01	4.32
CaO	4.44	4.12	7.00	6.94
Na_2O	2.13	5.70	3.17	3.43
K_2O	6.02	3.84	3.67	1.44
H_2O	1.06	1.02	1.25	1.03
P_2O_5	.58	.54	not det.	.40
	Mean of 3 Analyses	Mean of 10 Analyses	Mean of 5 Analyses	Mean of 16 Analyses

In the syenites the lime is low and the alkalies high ; in the diorites the lime is high and the alkalies low; in monzonite they are about equal. Study of the analyses shows that the monzonites form a chemically well-characterized "*Zwischengruppe*" between the syenites and diorites. They are true plutonic rocks of intermediate composition, with a medium lime percentage (6–7 per cent.), about the same amount of total alkalies, equally divided between potash and soda, high alumina (about 17–18 per cent.), and relatively low magnesia contents.

The structure of monzonite is that of a plutonic rock and is characterized by the fact that the orthoclase crystallized last in large allotriomorphic plates (*mesostasis*), partially enclosing the other minerals. The latter are plagioclase (usually labradorite or andesite) and augite. Olivine is abundantly present in certain basic members, but lacking in the more acid ones. Biotite, hypersthene, and hornblende occur sparingly. The accessory minerals are titanite, zircon, apatite, and iron ores.

Outside of the south Tyrol, rocks corresponding to monzonite have been described from Norway, Saxony, Schemnitz, Minnesota, and other parts of the world. An olivine monzonite occurs at Smälingen, while a rock from Rougstock, in the Bohemian Mittelgebirge, is a nepheline-bearing monzonite, and occupies a place between monzonite or augite diorite and theralite. The relations of monzonite to the syenites and diorites are graphically shown by a diagram. Monzonite occupies

the center of a triangle and by increase in soda passes through akerite and lavurikite to nepheline syenite; by increase of potash through plauenite and potash-feldspar-syenite to a hypothetical leucite syenite; and finally, by increase in lime, through alkali-rich diorite and alkali-poor diorite into an acid lime-rich norite, etc.

The pyroxenites of the region are basic peripheral facies of the normal monzonite. They were the first to solidify, as detached masses of pyroxenite are frequently included in the monzonite. The latter rock frequently shows porphyritic facies on its periphery, as is common in the Christiania region.

The monzonites and their peripheral facies are not the only eruptive rocks of Triassic age in this region. The complete series, and the sequence of eruption, is summed up by Brögger as follows:

(1) The oldest eruptions of Triassic time are represented by basic dikes and effusive rocks; melaphyre, augite-porphyrite, amygdaloids, tuffs, etc.

(2) Corresponding to the later eruptions of these basic dikes and effusive rocks, are also basic plutonic rocks (essentially pyroxenite, passing into gabbro-diabase, monzonite, etc.) of which relatively only insignificant masses are preserved as peripheral facies of more acid rocks.

(3) These more acid rocks, essentially monzonite, are of intermediate composition and belong to an independent rock-group within the series of the orthoclase-plagioclase rocks.

(4) Younger than the monzonites and the corresponding effusive rocks, are the red granites of Predazzo; also, probably, small veins of aplite and dikes of quartz porphyry.

(5) The youngest eruptions of the whole eruptive epoch are represented by an association of dikes; these are partly of ultra-basic composition, essentially camptonites, and partly of intermediate composition, commonly "liebeneritporphyre," or nepheline-bostonite. These two groups are related as complementary dikes. The bostonites appear generally to represent the youngest eruptions of the whole epoch.

Before applying the facts gained in the Tyrol to the study of the Christiania region, the author discusses the general laws governing the mechanism of eruption of plutonic rocks, and especially the hypothesis due to Kjerulf, Michel-Levy, and Suess, that the granites are batholithic, not laccolithic, and have displaced the invaded rocks by fusing and

assimilating them. He cites cases from the Christiania region where the granite has intruded the sedimentary beds in such a way that a portion of the latter has disappeared. The invading rock has metamorphosed the sediments, but the contact is sharp, and the granitite, which is normally very poor in lime, shows no chemical enrichment through "assimilation" of the calcareous beds with which it is in contact. During years of study, over magnificent exposures, in the Christiania region, Brögger has found no evidence in favor of any assimilation of the invaded sediments, nor for their "feldspathization" by the intruding magma. If the granite, then, has not absorbed the missing beds, where have they gone? They must, he says, be *underneath* the plutonic mass. "The plutonic rocks of the Christiania region have been brought into their present position by purely mechanical processes—by a squeezing up, and subsequent lateral intrusion, as a consequence of great subsidences of neighboring portions of the earth's crust. Their composition is not essentially influenced through assimilation of salbands, or through fusion of the overlying strata, but is the final result of differentiation processes of the original magma of the common magma-basin from which they all come. Their typical form is the '*Kuchenform*' of the laccolith." It is possible, however, that the Michel-Levy assimilation hypothesis and the Suess batholith hypothesis may apply to the great granite regions of the older "*Grundgebirge*" or to districts of folded, regionally metamorphosed rocks, but Brögger evidently considers it improbable.

The eruptive sequence of the Tyrolean region is compared with that of the Christiania region, and the facts are considered to support the view previously advanced by Brögger, that the differentiation sequence and the eruptive sequence are dependent upon the sequence of crystallization. The chemical composition of the hypothetical primary magma of the Austrian region is calculated by the method employed for the Christiania region in the preceding paper on the Grorudite-Tinguaite Series, and is found to have about the same silica percentage (65.2, as compared with 64.2 for the Christiania magma) but is rich in lime and poor in alkalies, while the Norwegian magma is poor in lime and rich in alkalies.

The paper concludes with some general considerations on the eruptive sequence of plutonic rocks. Such sequences are very difficult to work out in the field, and to be of service in determining the laws in accordance with which the differentiation processes have taken place

in a magma-basin, it is necessary to employ observations upon series of genetically connected eruptions, of a definitely bounded region, and belonging to a single eruptive period. The work of Iddings, Teall, Dakyns, and Wadsworth has shown that the *normal* series is basic — less basic — acid. This agrees with the explanation of differentiation through a diffusion toward the cooling surface of a magma-basin, which is regulated by the ordinary sequence of crystallization. According to Brögger the effusive rocks are in great part the products of a *secondary* differentiation from plutonic magmas; and, in general, the further away the magma-masses are from the original mother-magma, the more they have been subjected to secondary differentiation and the less regularity is observable in their eruptive sequence.

F. L. RANSOME.